

CLAIMS

What we claim is:

1. An apparatus for emitting electrons, comprising:
 - (a) a substrate having an emission side;
 - (b) a plurality of emitter tips protruding from the emission side of the substrate;
 - (c) a selected portion of a first dielectric layer contacting the emission side of the substrate between the emitter tips, each emitter tip being contiguous with an opening in the first dielectric layer;
 - (d) a dielectric support layer contacting the selected portion of the first dielectric layer, the opening in the first dielectric layer being contiguous with an opening in the dielectric support layer, the opening in the dielectric support layer having a size; and
 - (e) a gate layer contacting the dielectric support layer, the opening in the dielectric support layer being contiguous with an opening in the gate layer, the opening in the gate layer having a size, wherein the size of the opening in the gate layer is equal to or greater than the size of the opening in the dielectric support layer.
2. The apparatus of claim 1 wherein the first dielectric layer is composed of silicon dioxide and the dielectric support layer is composed of silicon nitride.
3. The apparatus of claim 1 wherein the selected portion of the first dielectric layer is selected to provide a plurality of cavities disposed between the emission side of the substrate and the support layer, each cavity surrounding a group of emitter tips.
4. The apparatus of claim 1 wherein the selected portion of the first dielectric layer is selected to provide a cavity disposed between the emission side of the substrate and the support layer, the cavity containing a group of emitter tips and at least one column, the column being disposed between the substrate and the support layer.
5. The apparatus of claim 1 wherein the emitter tips are carbon-based.
6. The apparatus of claim 1 further comprising a cover layer in contact with the gate layer.

- 1 7. An apparatus for emitting electrons, comprising:
- 2 (a) a substrate having an emission side;
- 3 (b) a plurality of emitter tips protruding from the emission side of the
- 4 substrate;
- 5 (c) a selected portion of a first etch layer contacting the emission side of
- 6 the substrate between the plurality of emitter tips, each emitter tip being contiguous
- 7 with an opening in the first etch layer;
- 8 (d) a first intermediate dielectric layer contacting the selected portion of
- 9 the first etch layer, the opening in the first etch layer being contiguous with an
- 10 opening in the first intermediate dielectric layer;
- 11 (e) a selected portion of a second intermediate dielectric layer contacting
- 12 the first intermediate dielectric layer, the opening in the first intermediate dielectric
- 13 support layer being contiguous with an opening in the second intermediate dielectric
- 14 layer;
- 15 (f) a dielectric support layer contacting the selected portion of the second
- 16 intermediate dielectric layer, the opening in the second intermediate dielectric layer
- 17 being contiguous with an opening in the dielectric support layer, the opening in the
- 18 dielectric support layer having a size; and
- 19 (g) a gate layer contacting the dielectric support layer, the opening in the
- 20 dielectric support layer being contiguous with an opening in the gate layer, the
- 21 opening in the gate layer having a size, wherein the size of the opening in the gate
- 22 layer is as large or larger than the opening in the dielectric support layer.

1 8. The apparatus of claim 7 wherein the first etch layer is composed of

2 aluminum.

1 9. The apparatus of claim 7 wherein the first intermediate dielectric layer is

2 composed of silicon nitride or stable silicon dioxide.

1 10. The apparatus of claim 7 wherein the support layer is composed of silicon

2 nitride or stable silicon oxide.

1 11. The apparatus of claim 7 wherein the selected portion of the second

2 intermediate dielectric layer contacting the first intermediate dielectric layer is selected to

3 provide a plurality of cavities disposed between the first intermediate dielectric layer and the

4 support layer, each cavity surrounding a group of emitter tips.

12. The apparatus of claim 7 wherein the selected portion of the second intermediate dielectric layer contacting the first intermediate dielectric layer is selected to provide a cavity disposed between the first intermediate dielectric layer and the support layer, the cavity containing a group of emitter tips and at least one column, the column disposed between the first intermediate dielectric layer and the support layer.

13. The apparatus of claim 7 further comprising a cover dielectric layer contacting the gate layer.

14. The apparatus of claim 7 wherein the emitter tips are carbon-based.

15. A method for manufacturing an apparatus for emitting electrons, comprising:

(a) providing a plurality of emitter tips protruding from an emitter material;

(b) depositing a first dielectric layer on the plurality of emitter tips and the emitter material, the first dielectric layer being composed of a dielectric material having an etch reactivity;

(c) depositing a dielectric support layer on the first dielectric layer, wherein the dielectric support layer is composed of a dielectric material having a different etch reactivity than the etch reactivity of the first dielectric layer;

(d) depositing a gate layer on the dielectric support layer;

(e) spinning a photoresist layer on the gate layer and etching the photoresist layer to form an exposed portion of the gate layer over each emitter tip;

(f) etching the exposed portion of the gate layer to form a selected size of an opening in the gate layer and exposing a portion of the dielectric support layer over the emitter tip;

(g) etching the exposed portion of the dielectric support layer to form a selected size of an opening in the dielectric support layer and exposing a portion of the first dielectric layer over the emitter tip; and

(h) etching the exposed portion of the first dielectric layer to expose one or more emitter tips.

16. The method of claim 15 wherein the plurality of emitter tips is provided by:

(a) providing a mold having an array of indentions on a selected surface of the mold;

(b) depositing emitter material onto the selected surface of the mold and into the indentions; and

(c) removing the mold to expose the plurality of emitter tips.

17. The method of claim 16 wherein the mold further comprises a plurality of arrays of indentions and a flat area on the selected surface interposed between the plurality of arrays.

18. The method of claim 16 wherein the array of indentions encloses a flat area on the selected surface.

19. A method for manufacturing an apparatus for emitting electrons, comprising:

(a) providing a plurality of emitter tips protruding from an emitter material;

(b) depositing a first etch layer on the plurality of emitter tips and the emitter material;

(c) depositing a first intermediate dielectric layer on the first etch layer, the first intermediate dielectric layer having an etch reactivity;

(d) depositing a second intermediate dielectric layer on the first intermediate dielectric layer, wherein the second intermediate dielectric support layer is composed of a dielectric material having a different etch reactivity than the etch reactivity of the first intermediate dielectric layer;

(e) depositing a support layer on the second intermediate dielectric layer;

(f) depositing a gate layer on the support layer;

(g) spinning a photoresist layer on the gate layer and etching the photoresist layer to form a selected size of an opening in the gate layer and exposing a portion of the support layer over each emitter tip;

(h) etching the exposed portion of the support layer to form a selected size of an opening in the support layer and exposing a portion of the second intermediate dielectric layer over the emitter tip, the selected size of the opening in the gate layer being as large or larger than the opening in the support layer;

(i) etching the exposed portion of the second intermediate dielectric layer to form an exposed portion of the first intermediate dielectric layer over the emitter tip;

(j) etching the exposed portion of the first intermediate dielectric layer to form an exposed portion of the first etch layer; and

(k) etching the exposed portion of the first etch layer to expose one or more emitter tips.

20. The method of claim 19 wherein the plurality of emitter tips is provided by:

(a) providing a mold having an array of indentions on a selected surface of the mold;

(b) depositing emitter material onto the selected surface of the mold and into the indentions; and

(c) removing the mold to expose the plurality of emitter tips.

21. The method of claim 19 wherein the mold further comprises a plurality of arrays of indentions and a flat area on the selected surface interposed between the plurality of arrays.

22. The method of claim 19 wherein the array of indentions encloses a flat area on the selected surface.

23. The method of claim 19 wherein the second intermediate dielectric layer is composed of silicon dioxide.

24. The method of claim 19 wherein in step (i) the second intermediate dielectric layer is further etched to form a cavity disposed between the first intermediate dielectric layer and the support layer.